Effect of roasting at 180˚c for 30 minutes on the sugars content of carob powder

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Abstract: This study aimed to investigate the effect of roasting at 180ºC for 30 minutes on the sugars of carob powder. We evaluated the reducing and non-reducing sugars as well as total sugars at carob powder before and after the roasting treatment. Also, we identified the sugars before and after the treatment by using high performance liquid chromatography (HPLC). Total sugars were increased by roasting treatment by percent 68.81%. Carob powder before roasting was contained 47.83% total sugars. HPLC- analysis for both powders were showed that, carob powder was contained a high amount from sucrose, maltose, glucose, arabinose and lactose. Roasting treatment was increased the succharides content, except, glucoromic.
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1. Introduction

Carob (*Ceratonia siliqua L.*) is a tree that has been widely grown in the Mediterranean region for a long time. It belongs to the *Caesalpinaceae* sub family of the family *Leguminoseae*(Yousif and Alghzawi, 2000). The production of carob pod in the world is estimated at about 315000 tons per year from the total area is approximately 200000 hectares and the yield depends on cultivar, region, and cultural practices (Makris and Kefalas, 2004). The mature fresh fruit is made up of about 90% of pod (known as kibble) and 10% of seed. The fruit of carob tree (carob pod) has been used locally as feed and food mainly due to its sugary pulp (48-57% of sugars) in total sugar content that include many sucrose (which constitutes about 30%), glucose, fructose, and maltose (Santos, et al., 2005). Additionally, carob contains about 18 % cellulose and hemi-cellulose (Bouzouita, *et al.*,2007).

In the production of carob powder, different time-temperature combinations are used and the final product characteristics such as lightly, medium or highly roasted carob powder. In conventional roasting of the carob kibbles processors generally use the temperature range of 120-180º C (mostly around 150ºC) and the time ranging from 10 to 60 minutes. During the roasting process of carob powder, important chemical reactions including sugar caramelization and Millared reaction take place, which cause significant changes in product quality (Yousif and Alghzawi, 2000). Also, Hilal Şahin, *et al.* (2009) mentioned that, both roasting temperature and time strongly affected the chemical properties of carob powder. Furthermore, the roasting time was a critical factor determining the overall quality of the product.

The aim of this study was to investigate the effect of roasting at 180ºC for 30 minutes on the sugars of carob powder.

2. Materials and Methods:

1- Materials:

Carob pods (*Ceratonia* siliqua *L.*) were purchased from a local market in Jeddah, Saudi Arabia. All chemicals reagents were purchased from El-Gomhoria Co. in Cairo, Egypt.

2- Methods:

Preparation of carob powder:

5kg. carob pods were obtained and seeds were removed, pods then were kibbled, milled, and roasted in a drying oven at 180ºC for 30 minutes. The roasted samples were then ground in a mill (Molineux) and passed through the screen (60 meshes) to provide uniform particle size. Carob powder samples were then placed into polyethylene bags and kept at 4ºC until analysis.

Sugar measurements:

The total sugars (Glucose, Fructose and Sucrose) content of the carob powder (before and after roasting) were quantified by hydrolysis with IMHCL at pH1 and 80-85ºC for 30 minutes and neutralization with 1M NaOH. The 3,5-dinitrosalicylic acid (DNS) method (Miller 1959) was used to determine the sugar content as glucose. Reducing sugar was determined by the same method but without hydrolysis. The standard curve was in the range of 0.1 – 1 (gL^{-1}) glucose solution (R^2 = 0.98).

Identification of Sugars by HPLC:

The sugar extraction was realized with dist. water, weight sample was immersed in the adequate amount of dist. water and mechanically shook in open flask at ambient temperature (20-25ºC) until reaching extraction equilibrium. Then the mixture

was filtered and the extract was analyzed for its content of sugars by the high performance liquid chromatography (HPLC). The apparatus is equipped with a differential refract meter Isocratic separation of the compounds was carried out at flow rate of 0.7 ml/min. The column was an amino-bonded column 4.6DL-250 mm-5µm and the mobile phase was a mixture of acetonitrile (75:25) for isocratic elution. The standards were Rhaminose, Sorbitol, Manitol, Mannose, Glucuronic, Glacturonic, Raffinose, Ribose, Arabinose, Xylose, Stachyose, Sucrose, Galactose, Lactose, Maltose, Fructose and Glucose, which were obtained from Sigma Co. The sugars are determined by the method as described in A.O.A.C (Bugner and Feinberg, 1992).

3. Results and Discussion:

This study was designed to know the difference in the sugar content between carob powder and roasted carob powder (roasted at 180ºC for 30 minutes). The chemical analyses of both samples were shown in Table (1). Total sugars of carob powder before roasting were 47.83%, reducing sugars were 18.71%, while, non-reducing sugars were 29.12%. These results were in agreement with many researchers such as Owen, *etal.* (2003), they reported that, the total sugars in carob pulp were 40-60 % and Santos, *et al.*(2005) mentioned that, the pulp of carob was contain about 48-57% of sugars.

The same Table, shows that, roasted carob powder was contain 14.92% as total sugars, 6.53% reducing sugars and 8.39% as non-reducing sugars. These results were shown the effect of roasting in the sugar content. The roasting was increased the sugars content because the high temperature in the roasting was caused sugar caramelization and Millard reaction. The Millard reaction which is a part of non-enzymatic browning reaction system becomes predominate when components such as reducing sugars and amines react with each other during thermal treatment (Gökmen, *et al.* 2007).

Generally, roasting of carob powder at 180ºC for 30 minutes was increased sugars approximately 68%.

Table (1): Total sugars, Reducing and Non- reducing Sugars in carob powder before and after roasting

Component	Carob Powder before roasting (%)	Carob Powder after roasting (%)	Loss percentage (%)
Total Sugars	47.83	14.92	68.81
Reducing Sugars	18.71	6.53	65.10
Non-reducing Sugars	29.12	8.39	71.19

HPLC-analysis for powder of carob and roasted carob were carried out for identification of sugars according to the method described in Santos, et.al. (2005). Figures (1 and 2) show the chromatograms of the carob powder and roasted carob powder, respectively. Table (2) shows the succharides of the identified sugars. As seen in Table (2), succharides component (Sucharide, Glucuronic, Stachyose, Galacturonic, Sucrose, Maltose, Glucose, Lactose, Xylose, Galactose, L-Rhaminose, Mannose, Raffinose, Arabinose, Manitol, Sorbitol, and Ribose) could be identified in the carob powders before and after roasting. The ratios of components in the carob powder were higher than the ratios of components in the carob powder were higher than the ratios of components in the roasted carob powder. HPLC-chromatogram shows that, carob powder are contained a high amount from sucrose (8.6036%), maltose (2.5971%), glucose (1.7713%), arabinose (1.4975%), and lactose (3.1259). Roasting treatment was increased the sugars content, except, glucoromic, was lower in carob powder (0.0880%) but at roasted carob powder was (0.1092%). Roasted carob powder was contained sucrose (0.2310%), maltose (0.2620%), glucose (0.1706%), and lactose (0.1898). As seen in Table (2) and fig. (1 and 2), the roasting treatment at 180ºC for 30 minutes was increased the sugars amount by high percentages, this due to Millard reaction.

On the other hand, (Moniz, 2008) reported that, carob was contained sucrose (42.68 g/100g), glucose (8.54 g/100g), fructose (5.97 g/100g) and 5.22 g/100g of pintol.

Table (2): Identification of sugars in carob powder before and after roasted at 180ºC for 30 minutes.

Succharide	Before roasting (%)	After roasting (%)
Glucuronic	0.0880	0.1092
Stachyose	0.1146	0.0765
Galacturonic	0.6228	0.0862
Sucrose	8.6036	0.2310
Maltose	2.5971	0.2620
Glucose	1.7713	0.1706
Xylose	0.1957	0.0608
Galactose	0.0747	0.0180
L-Rahminose	0.0808	0.0496
Mannose	0.0715	0.0552
Raffinose	0.9892	0.0768
Arabinose	1.4975	0.0161
Manitol	0.1850	0.0248
Sorbitol	0.0603	0.0130
Ribose	0.0093	0.0009
Lactose	3.1259	0.1898
Fructose	0.6769	0.0486

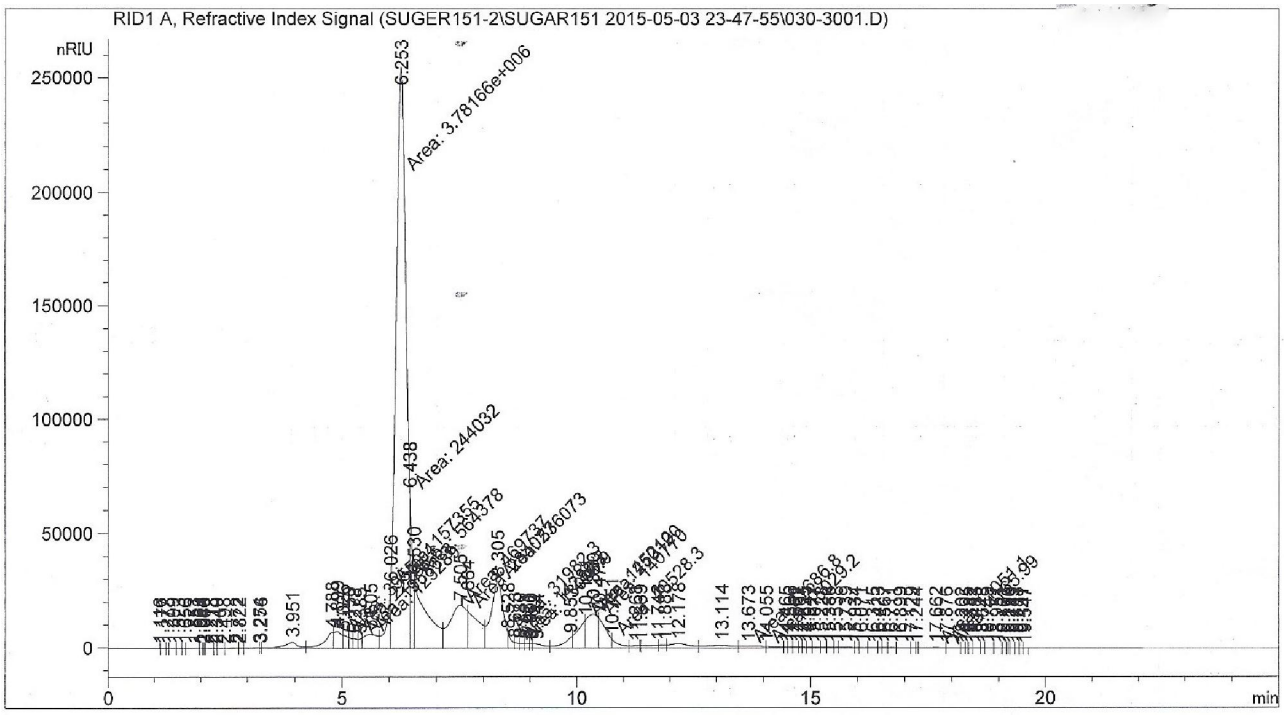

Fig. (1): Identification of sugars in carob powder before roasted at 180ºC for 30 minutes.

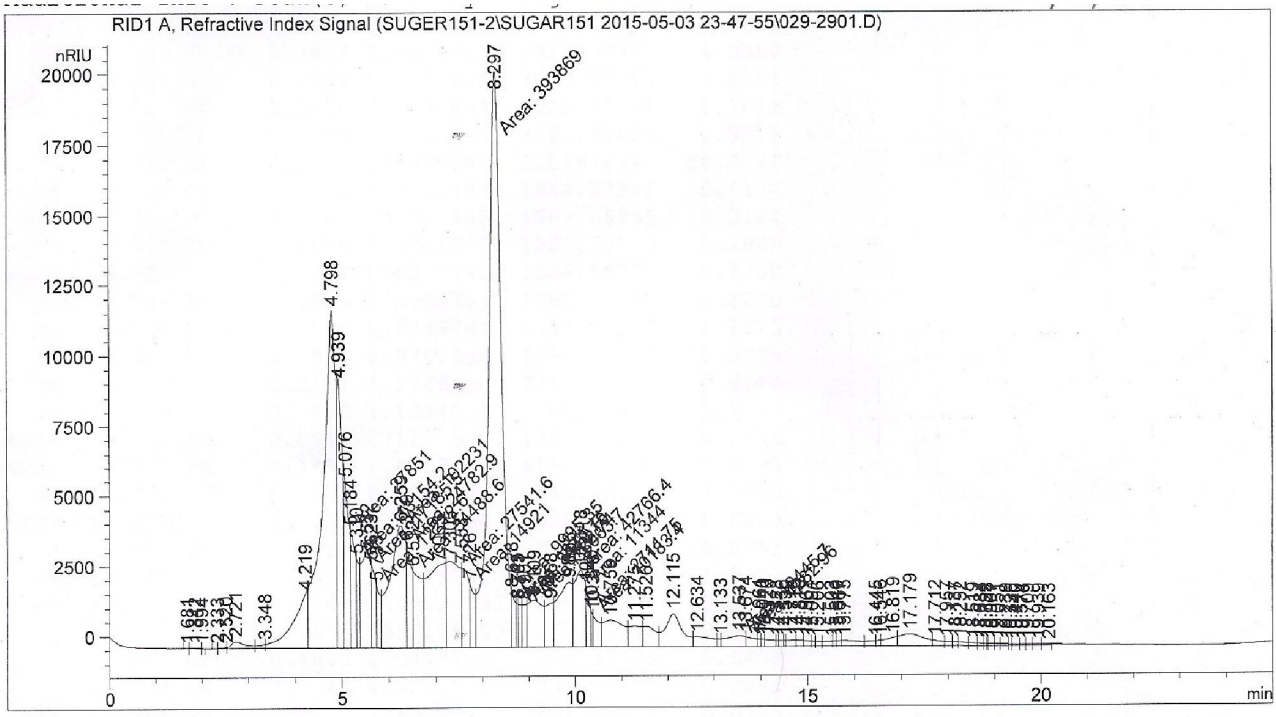

Fig. (2): Identification of sugars in carob powder after roasted at 180ºC for 30 minutes.

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